RESEARCH DEPARTMENT

VISIT TO ROME: 29TH AUGUST - 1ST SEPTEMBER 1960

Report No. A-059

(1960/25)

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SUMMARY

A Fernseh G.m.b.H. television standards converter used for conversion between the European 625-line, 50 fields/second and the American 525-line, 60 fields/second standards, was seen at Ciampino Airport, and the quality of the converted pictures was assessed. A Japanese slow-scan system used for transmitting short sequences of pictures to Tokyo was seen at Fiumicino. A brief visit was paid to the Rome studios of RAI, and recent developments were discussed with RAI engineers.

1. INTRODUCTION

I travelled outwards during the morning of 29th August and returned during the afternoon of 1st September. My principal object was to see a standards converter made by Fernseh G.m.b.H. for the Columbia Broadcasting System (C.B.S.), who were operating it in Rome during the Olympic Games. I was also able to see a Japanese slow-scan system, used for transmitting short sections of film to Tokyo, and to visit the Radiotelevisione Italiana (RAI) studios in Rome and have some discussions with RAI engineers.

2. THE FERNSEH STANDARDS CONVERTER

2.1. General

Fernseh G.m.b.H. make a standards converter[1] incorporating a Vidicon camera for conversion between standards having nominally equal field frequencies. More recently they have developed a modified version capable of conversion between European and American television systems, where the field frequencies differ by 10 c/s. At the time of the visit only one of these modified standards converters had been completed; this had been sold to C.B.S., who operated it near Rome during the Olympic Games.

The technical principles have been outlined by Lord,[2] and in the manufacturer's literature,[3] and will not be discussed in detail here, since I was more concerned with the quality of the converted pictures. It is sufficient to say that flicker is removed by inserting a reference pulse in the incoming signal to produce a bright stripe on one side of the displayed picture. A pulse corresponding to this stripe appears in the output of the camera and is used to control the gain. The same principle is used in the B.B.C. Research Department standards converter.[4]

The C.B.S. installation comprised three Ampex recorders and the standards converter, which were installed in a disused cinema at Ciampino Airport. RAI provided television pictures by microwave link, and these were converted from the 625-line, 50 fields/second European standard to the 525-line, 60 fields/second American standard. The standards converter was operated by Mr. Consentino of C.B.S. The engineer in charge of the C.B.S. Olympic team was Mr. A.F. Schoenfuss.

A reserve for the standards converter was provided by a converter produced and operated by Radiodiffusion-Télévision Française (R.T.F.) in Paris, where duplicate recordings were made. Mr. Consentino stated that the R.T.F. converter was still at the bread-board stage and produced poor pictures exhibiting both smear ,and flicker.

Mr. Consentino had himself developed a standards converter, using a Vidicon camera, and had used it in New York to convert ITV recordings of the Royal Wedding in May 1960. He had found it necessary to incorporate means of correcting the output of the Vidicon camera for additive shading signals and for non-linearity, before applying the automatic gain control. When the Fernseh standards converter was offered for acceptance, these measures had not been incorporated and the flicker was unacceptable. Mr. Consentino remained with Fernseh, to assist in modifying the converter to deal with shading and non-linearity, and in this way it was made satisfactory in time for delivery to Rome.

I understand that a standards converter of the same type has been ordered by the National Broadcasting Company.

2.2. Picture Quality

I watched conversion in progress for about three hours. The incoming pictures were of excellent quality, though produced with 3 in. image orthicon cameras. The scenes contained much movement, consisting of swimming, boxing and fencing. The boxing was particularly useful for assessing movement smear, since rapid panning was necessary. I saw the pictures on 14 in. monitors at the input and output of the standards converter, and after recording and replay.

It is convenient when describing picture quality to use the Research Department standards converter,[4] which operates on similar principles, but uses a C.P.S. Emitron camera, as a standard of picture quality.

As with the Research Department standards converter, no fault could be found with the grey scale.

The resolution appeared similar to that of the Research Department standards converter and offered little scope for improvement. During much of the time, there was present a locked 5 Mc/s interfering signal (caused by an operating error leading to break-through of a test signal in the display unit), which produced fine vertical stripes on the display. These stripes were visible in the output of the converter, having lost not more than 6 dB in amplitude.

The noise level appeared similar to, or very slightly better than, that produced by the Research Department standards converter.

As might be expected from the small size of the display tube, phosphor grain noise was visible, but only slightly worse than that produced by the Research Department standards converter, and there was no trace of background other than grain noise, such as large blotches. Horizontal streaks, produced by the action of background on the automatic gain control circuits, were rather less visible than in the Research Department standards converter.

For most of the time, flicker was on the verge of visibility, as with the Research Department standards converter, but it occasionally became appreciably worse at the top of the picture. Mr. Consentino attributed this to failure of the voltage regulators to operate correctly, owing to the fact that the supply voltage was outside the limits. It may be remarked that it is easier to reduce flicker to a low level if the 50 c/s and 60 c/s field frequencies are rigidly locked together, and phased for minimum flicker. In both the B.B.C. and Fernseh standards converters the two supply frequencies are rigidly locked together, since the motor-generators incorporate synchronous motors and toothed belts, but in neither case is it customary to arrange the field phasing for best results. During my visit, both the incoming and outgoing signals were synchronous with the corresponding supplies, so that field frequencies were locked in the ratio 5:6. Although the field phasing had not been chosen deliberately, it appeared to me that it was not very far from the optimum, so that I may have assessed the flicker under adventitiously favourable conditions.

When watching moving scenes, I was unable to detect any smearing associated with long time delays of the order of many fields; in other words trails like comets' tails did not follow rapidly moving objects. Smear, in the sense of loss of detail in moving objects, was, however, visible to about the same extent as in the Research Department standards converter. It was sufficient to reduce considerably, without eliminating, the 10 c/s "judder", which is inherent in conversion between differing field frequencies, and which is particularly apparent when fast panning occurs. It is a matter of opinion whether a certain amount of loss of detail with motion is desirable, since it tends to mask judder, but in my opinion both the Fernseh and Research Department standards converters are close to the optimum in this respect.

The good performance of the Fernseh standards converter in respect of smear is surprising, in view of the fact that when the automatic gain control is switched off the modulation depth associated with flicker is only 15% (this was demonstrated to me on an oscilloscope). In the Research Department standards converter, the modulation depth is 25% under the same conditions and it might therefore be expected that there would be much less smear. It seems just possible that the combination of afterglow in the cathode-ray tube with persistence of charge carriers in the Vidicon target gives a better compromise between flicker and smear than does afterglow alone.

The display cathode-ray tube operates at a peak-white brightness of 2000 ft-lamberts compared with 30 ft-lamberts in the Research Department standards converter. Since the performance of this cathode-ray tube appeared superior to any available in this country, I checked the brightness and found it to be as claimed.

2.3. Operation

The standards converter was operated by one man (Mr. Consentino) only. He adopted quite a relaxed attitude towards this work, making adjustments rarely and then only to correct variations in the incoming picture. The circuits for correcting shading signals and non-linearity in the camera might have been expected to require most adjustment, but Mr. Consentino said that he had not touched them since the Olympic Games began several days previously.

2.4. Conclusions

The standards converter appears compact, stable, and convenient to operate. The picture quality is of the same order as that given by the B.B.C. Research Department standards converter. This comparison is not, however, a very precise one, since the pictures produced by the two standards converters were seen at different times and under different conditions. For example, the Research Department standards converter was usually seen converting 405-line pictures, or bad 819-line pictures, whereas the Fernseh standards converter was seen converting good 625-line pictures. Moreover, factors such as the size of the monitor and the room illumination have been found to influence subjective comparisons considerably.

3. JAPANESE BROADCASTING CORPORATION SLOW-SCAN EQUIPMENT

During the Olympic Games, the Japanese Broadcasting Corporation (N.H.K.) operated a slow-scan system for transmitting short sequences of moving pictures to Japan by short-wave radio link. The equipment was installed in the airport buildings at Fiumicino (this new airport is not yet operational). RAI provided live television pictures by radio link.

The engineer in charge of this equipment was Mr. K. Hiwatashi. Arrangements for me to see the equipment were kindly made by RAI and I was taken to Fiumicino by Dr. R. Salvadorini and Dr. M. Agresti.

The equipment is divided into three parts; a variable-speed telerecorder, a slow-speed film scanner and transmission equipment. The film traction of the telerecorder appears to be continuously variable in speed under the control of the producer - in effect an editor - who watches the incoming picture on a monitor. When he decides to record, he quickly turns up the supply to the traction mechanism from zero to whatever value he has chosen, allows the telerecorder to run for as long as necessary - usually only a few seconds - and then stops it. The film motion is intermittent, moving one frame at a time in the usual manner and one television field is recorded on each film frame. In this manner any number of frames between one and ten could be exposed in each second. In practice, most or all scenes were recorded at eight frames per second, higher speeds never being used. Slower speeds had been visualised as being suitable for the more ponderous types of wrestling, but I formed the impression that they had not been used.

The exposed film passes directly from the telerecording camera into a rapid-processing tank, where it is processed in about two minutes. The processed negative film is then taken to the slow scanner. This operates more slowly than the B.B.C. Cablefilm equipment,[5] taking thirty seconds (as compared with eight) to scan each frame. Scanning is vertical rather than horizontal, since this was thought to eliminate line beating with less loss of resolution. (It may be remarked that from time to time the relative merits of vertical and horizontal scanning for Cablefilm have been discussed in Research Department.) Each frame is scanned in 175 vertical lines.

The transmission occupied a single telephone channel in the 10 Mc/s band, which was hired from the Italian authorities. Two sub-carriers are used for transmission, and these are frequency-modulated together by the video signals originating in the slow-speed scanner. One sub-carrier is deviated between 500 and 1100 kc/s and the other between 2000 and 2600 kc/s. The video-frequency bandwidth was said to be adequate to display 115 independent picture elements along each vertical line. This would require a video bandwidth of about 350 c/s. A bandwidth of 500 c/s is, however, referred to in a technical description obtained subsequently. At the receiving point in Japan, the two sub-carriers are demodulated separately to produce two vision signals. These are tested for noise by a gate operating in the line-suppression period, and the least noisy is automatically selected.

It had originally been intended to use a more subtle diversity system, in which spot wobble was used to double effectively the number of vertical scanning lines at both receiver and transmitter. At the transmitting end, the output of the photomultiplier was sampled by two interleaved trains of pulses, each having a recurrence frequency equal to the wobble frequency (31·25 kc/s). Two outputs were derived in this way, one corresponding to each of the pair of lines into which each of the 175 scanning lines had been divided, and these were used to modulate the two sub-carriers separately. At the receiving point, the two signals were automatically examined for noise in the suppression periods. If both were satisfactory, they were modulated by separate interleaved trains of pulses, added, and applied to the telerecording display tube. In this way, the equipment operated as a facsimile system scanning in 350 vertical lines. If, however, one of the sub-carriers proved noisy, the other was applied alone to the display tube, so that the number of independent vertical lines was halved.

Mr. Hiwatashi said that the more refined diversity system described above proved impracticable to instrument, in view of the difficulty of maintaining equality between the gains of the two channels.

One interesting feature of the equipment was the monitor. Since thirty seconds are taken to scan one frame, the use of a cathode-ray-tube monitor would not be very satisfactory, even with a long-afterglow screen. A commercial facsimile receiver, of a chemical type requiring no processing, was therefore used. This enabled the frame being sent at any moment to be compared with frames sent previously. The contrast range and grey scale were, however, poor.

The equipment was used for four or five hours each day during the Olympic Games, transmitting a total of just over one minute of programme.

It appears that the horizontal and vertical resolutions must each have been about half that achieved in the B.B.C. Cablefilm equipment. Taking this and the poor portrayal of motion into account, the quality of the pictures must have been appalling.* Any substantial improvement would, however, have entailed a very heavy expenditure on radio circuit time. It would be interesting to learn whether the pictures had real programme value. In any case some of the techniques merit further attention.

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*This estimate is confirmed by a description, accompanied by samples of the received pictures, subsequently supplied by Mr. Nomura of N.H.K.

4. VISIT TO RADIO TELEVISIONE ITALIANA STUDIOS IN ROME

I was shown the RAI studios by Dr. Agresti, and some interesting technical discussions (not confined to studio equipment) took place. I do not feel qualified to comment on the arrangement of the studios generally; moreover, the studios were virtually stripped and abandoned to provide outside broadcast facilities for the Olympic Games. The following points may, however, be of interest.

Composite pictures are more popular in RAI than in the B.B.C. Studio control desks are provided with special-effects mixers giving a wide range of different forms of wipe, which can sometimes be used instead of inlay equipment. Among the waveforms generated electronically is one giving a circular inlay. I did not have time to discuss the ingenious circuit that must have been required.

Field trials have been conducted on a method of slave locking which enables a composite picture to be formed from three or more different sources. The method does not require additional lines for locking, but is applicable only when the composite programme is available, for example by receiving broadcast transmissions, at each contributing point. The procedure is as follows.

The pulse generator at the controlling point is switched to crystal and the synchronising waveform produced is used for transmission. At each remote contributing point, the programme is picked up, normally by receiving broadcast transmissions, and the synchronising pulses are used to trigger a new set of pulses, which are given a predetermined time delay. This delay is so adjusted that the total delay between a synchronising pulse leaving the control centre for the transmitters, and the corresponding pulse coming back with the contribution to the programme, is an integral number (presumably even) of fields. Dr. Agresti said that in one trial of this system combined contributions to the programme from Milan, Palermo and a third point on the Adriatic Coast were used to form one composite picture.

The method of slave locking described above appears essentially the same as one proposed by Mr. D.J. Denholm of the B.B.C. Planning and Installation Department in 1956. One reason for not adopting this method in the B.B.C. was the fact that it entailed operation asynchronously from the supply mains. British television receivers may be more sensitive to mains hum than Italian receivers, which occasionally have to operate asynchronously.

In order to facilitate the alignment of composite pictures, a facility is provided whereby the producer can superimpose on the viewfinder of a camera in the local studio a faint picture derived from another source. At the same time, an inlay waveform can also be applied to the viewfinder at low level. The camera operator then sees his own picture in its entirety, the picture produced by the other source in its entirety, and the precise area in which one picture is to be inlaid in the other. This enables him to achieve registration between his own and the other picture.

Facilities are provided whereby the producer in a studio control room can either fade or cut to a contribution from outside the studio by remotely controlling equipment in the central control room. In this way, it becomes unnecessary for a contributed video signal to pass into and out of the studio control room. (The signal is, of course, fed to the studio control room for the producer's monitors.) This facility simplifies timing problems.

It is usual to operate synchronously with the supply mains, but the pulse generator is switched to the crystal oscillator whenever the mains frequency passes outside the range 49¼ c/s to 50¾ c/s, when the method of slave locking referred to above is employed, and when making contributions to the Eurovision network. I was told that the supply mains throughout Italy are synchronous for about 80% of the time.

5. PRECISION OFFSET

Dr. R. Busi[6] of RAI has described a method of achieving precision offset when operating synchronously with the supply mains. In view of the fact that Designs Department is conducting field trials of this method, I took the opportunity of calling on Dr. Busi to enquire whether there had been any further developments since the publication of his paper.

Dr. Busi said that co-channel interference is a serious problem in Italy. For example, two main stations operating on the same channel may be situated on either side of a mountain range, and satellite stations serving valleys in the mountains may have to receive one or other station for re-transmission.

Further laboratory experiments have confirmed that the Busi system gives a useful improvement, and that the equipment accepts the variations in field frequency normally experienced when operating in synchronism with the supply mains. The optimum offset frequency was, however, found to be some 6 c/s above the expected value (209 × field frequency). Dr. Busi could offer no explanation for this surprising result, and he advised that it should be taken with reserve until further experiments had been conducted.

No field trials using radiated transmissions have yet been conducted, but it is hoped to install equipment at two stations within the next few months.

6. ACKNOWLEDGEMENTS

Thanks are due to Dr. A. Riccomi of RAI and to the engineers of RAI, C.B.S. and N.H.K. mentioned above, for much help. I appreciate this the more in view of the pressure under which they were working during the Olympic Games.

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